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KEWB IRRADIATION

Photographs and tabular data illustrating the results obtained at KEWB were unavailable for the May Progress Report due to a slippage in irradiation schedule caused by a reactor malfunction. This data is presented herewith.

The ten burst series at KEWB resulted in an exposure of 2.34(15) nv_et. The data secured in this series of irradiation bursts indicated no significant permanent amplifier degradation as shown in the fold-out tabular data sheet while the other tabular data indicates slight changes in the Beta and other characteristics of the transistor used in each amplifier. The amplifiers did exhibit a much higher degree of transient effects than secured at TRIGA, as shown in the photographic illustrations for pulses 6 and 10. Oscillographic reproduction of burst No. 1 was lost due to a misunderstanding regarding countdown. All of the other oscillographic recordings were similar to that secured for bursts 6 and 10 and hence it would be redundant to show these in this report. There were no temporary effects observed, the interruption in the amplifier outputs lasting only as long as the burst, whose half amplitude width was $\sim$3 milliseconds.

Unlike the TRIGA series, there was noise introduction into the amplifier inputs, which would account for a portion of the amplifier output transient. This is illustrated in Figure 1 of Pulse Irradiation No. 6 photographs.

At TRIGA it was noted that the transient effects disappeared after an exposure of $\sim 3 \times 10^{14}$ $nv_e t$. Analysis of KEWB oscilloscope data does not indicate such an occurrence, in this environment. However, both at TRIGA and KEWB the d.c. current drawn by the amplifiers exhibited a transient during the irradiation pulse which at TRIGA decreased with succeeding bursts. Photo-oscilloscope pictures were taken of this phenomena for several KEWB bursts. It should be noted that Figure 1 of this foldout illustrates the change in summed d.c. supply current for all three amplifiers, while Figures 2 and 3 delineate the current change for Amplifier S/N 5C only.

GTR IRRADIATION

The General Dynamics GTR irradiation commenced on June 17th. The West Pallet location was used, with the specimens against the reactor face. Approximately 30-35 hours after reactor start-up, the Litton test was discontinued, all test specimens but one having their gain completely degraded. One amplifier still possessed $\sim$30% of its pre-irradiation gain. Inasmuch as the nuclear exposure is yet to be determined (receipt of dosimetry foils is currently awaited), this report does not include the gyro preamplifier performance.

Two unusual conditions were encountered in this test. The "B" amplifier transistor exhibited a collector to emitter short, pre-irradiation. This condition did not exist when the specimens were shipped from Litton. An uncharacterized 2N700 was substituted. Reactor startup schedule did not permit time for component or system characterization (excepting of course closed loop gain).

This amplifier degraded faster than the other two (A & C). Amplifiers A & C (as well as other specimens) employ the 2N700A which has a much higher typical Beta (Minimum 4, Maximum 50) than the 2N700 (Min. 4, Typical 10). Amplifiers A & C transistors had Beta's of 18.

The heater blanket in the test specimen environmental chamber failed, just prior to reactor startup. This was compensated for by raising the pallet environmental air temperature. As the reactor went up to power, and gamma heating was secured, the pallet input air temperature was adjusted to maintain the desired 55°C environment. Correction juggling was satisfactory, the desired environment being maintained within reasonable limits except at one point near the start of irradiation, and later at the end of the irradiation where the cooling coils of the air exchanger iced up. This data will be shown in the GTR test results in the July progress report.

REACTOR SCHEDULE

The schedule for the remaining irradiations is as follows:

SPRF	July 31, Aug. 1, 2.
FORD	Oct. 16-18
CP-5	Oct. 21-29

These dates, excluding SPRF, are tentative, pending confirmation from the reactor facilities.

CORRELATION EXPERIMENT

Inasmuch as insignificant permanent damage was expected in the pulse irradiations and this would limit the extent of spectra-damage comparison, utilizing the gyro preamplifier data, Litton included 8 FET's in each irradiation. Their degradation both in the pulse and steady state environments will be correlated against degradation in the gyro preamplifiers in those environments where damage occurred. The results secured to date, for averaged GM data, is as follows:

TRIGA GM/GM_o $0.7 \pm 4 \times 10^{14}$ nv_et

KEWB GM/GM_o $0.7 \pm 1 \times 10^{15}$ nv_et

The spectrum for these two reactors appears quite similar. Data for GTR has not been reduced, and hence can not be compared at this time.

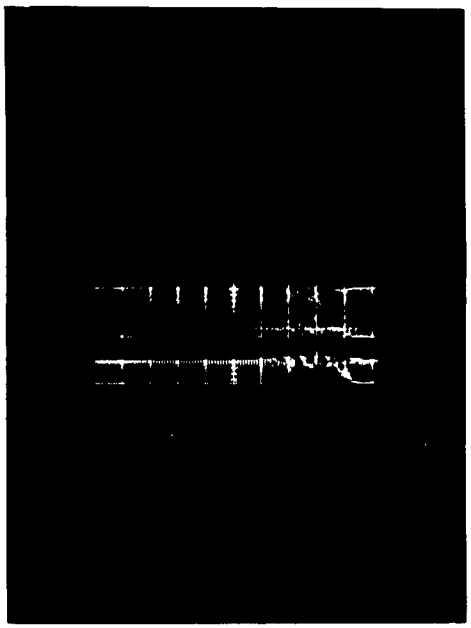

FIGURE 1

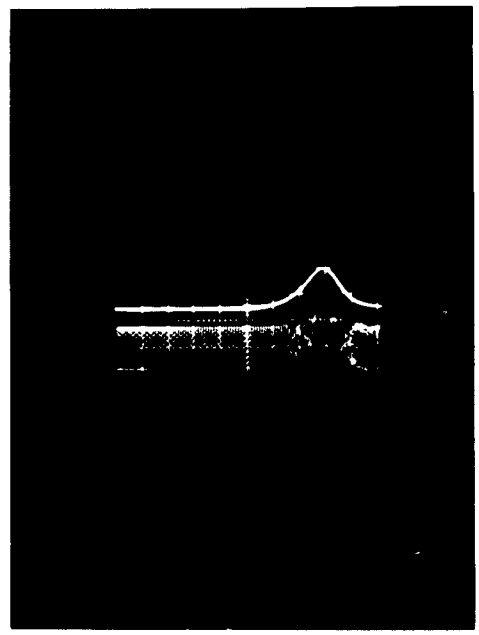

FIGURE 2

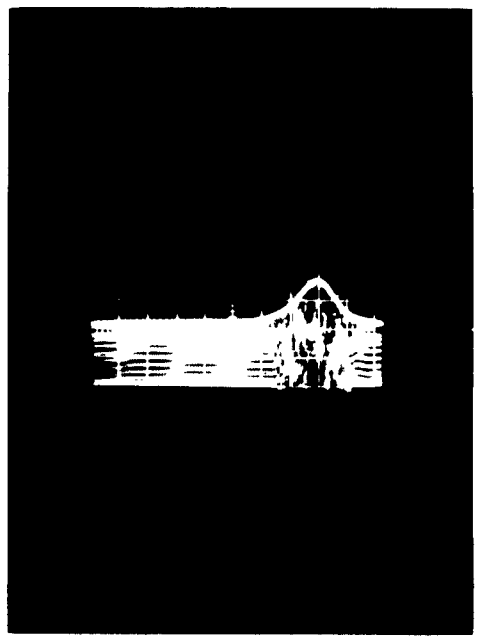

FIGURE 3

KEWB

PULSE IRRADIATION

AMPLIFIER CURRENT MEASUREMENTS

DATE: May 23, 1963 TIME: 1238-1442

AMBIENT AIR TEMPERATURE: 55-60°C

ZERO AND ELAPSED TIME: Left (Start of Trace) to Right.

FIGURE 1

PULSE IRRADIATION: 7
GYRO PREAMPLIFIER S/N 5A, 5B, 5C
SWEEP: 2 msec/cm
DC SUPPLY CURRENT (I_t) ALL AMPLIFIERS:
Upper Trace 10 ma/cm
AC OUTPUT: Lower Trace 5.0 V/cm (S/N 5C)

FIGURE 2

PULSE IRRADIATION: 8
GYRO PREAMPLIFIER S/N 5C
SWEEP: 2 msec/cm
DC SUPPLY CURRENT (I_t): Upper Trace 20 ma/cm
AC OUTPUT: Lower Trace 5.0 V/cm

FIGURE 3

PULSE IRRADIATION: 9
GYRO PREAMPLIFIER S/N 5C
SWEEP: 2 msec/cm
RADIATION DETECTOR: Upper Trace 20 V/cm
DC SUPPLY CURRENT (I_t): Lower Trace 20 ma/cm

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Condition	Closed Loop Gain[1]			I_t (ma)			Air Temp. °C	$E_n < 0.48$ ev			$E_n > 0.4$	
	A	B	C	A	B	C		nv_o	$nv_o t$	Acc. $nv_o t$	nv_e	nv_e
Baseline	9	9	9.2	7.1	7.1	7.0	48	———	———	———	———	———
Afterburst No. 1	9	9	9.2	7.1	7.1	7.0	55	1.14(16)	3.40(13)	3.40(13)	9.17(16)	2.74
No. 2	9	9	9.2	7.1	7.2	7.0	56	9.74(15)	3.04(13)	6.44(13)	7.27(16)	2.27
No. 3	9	9	9.1	7.1	7.2	7.0	53	9.70(15)	3.14(13)	9.58(13)	7.19(16)	2.33
No. 4	9	9	9.1	7.0	7.1	7.0	58	1.04(16)	3.29(13)	1.29(14)	8.67(16)	2.73
No. 5	9	8.9	9.1	7.0	7.1	7.0	53	8.66(15)	2.83(13)	1.57(14)	6.46(16)	2.11
No. 6	9	8.9	9.1	7.0	7.1	6.9	51	9.50(15)	3.04(13)	1.87(14)	7.05(16)	2.26
No. 7	9	8.9	9.1	7.0	7.1	6.9	58	9.90(15)	3.12(13)	2.19(14)	7.37(16)	2.32
No. 8	9	8.9	9	7.0	7.0	6.9	50	9.50(15)	3.07(13)	2.49(14)	7.09(16)	2.29
No. 9	9	8.9	9	7.0	7.0	6.9	55	1.04(16)	3.29(13)	2.82(14)	7.73(16)	2.45
No. 10	9	8.9	9	7.0	7.0	6.9	63	1.05(16)	3.28(13)	3.15(14)	7.79(16)	2.44

NOTES:
1. All measurements based on 1 volt P-P input at 5 Kc.
2. Calculated from reactor spectrum.
3. Ergs/gm (C) accumulated, R/sec per burst.

TABLE

GYRO PREAMPLIFIERS S/N 5A, 5B, 5C
PERFORMANCE IN KEWB PULSE REACTOR

$E_n < 0.48$ ev		$E_n > 0.48$ ev			$E_n > 10$ Kev $(Pu)^2$			$E_n > 0.6$ Mev $(Np)^2$			$E_n > 1.5$ Mev $(U)^2$			$E_n >$
$nv_o t$	Acc. $nv_o t$	nv_e	$nv_e t$	Acc. $nv_e t$	nv_f	$nv_f t$	Acc. $nv_f t$	nv_f	$nv_f t$	Acc. $nv_f t$	nv_f	$nv_f t$	Acc. $nv_f t$	nv_f
3.40(13)	3.40(13)	9.17(16)	2.74(14)	2.74(14)	2.92(16)	8.73(13)	8.73(13)	1.51(16)	4.52(13)	4.52(13)	7.18(15)	2.15(13)	2.15(13)	2.42(15)
3.04(13)	6.44(13)	7.27(16)	2.27(14)	5.01(14)	2.50(16)	7.81(13)	1.65(14)	1.30(16)	4.04(13)	8.56(13)	6.11(15)	1.90(13)	4.05(13)	1.92(15)
3.14(13)	9.58(13)	7.19(16)	2.33(14)	7.34(14)	2.49(16)	8.07(13)	2.46(14)	1.29(16)	4.17(13)	1.27(14)	6.10(15)	1.98(13)	6.03(13)	1.91(15)
3.29(13)	1.29(14)	8.67(16)	2.73(14)	1.01(15)	2.68(16)	8.45(13)	3.31(14)	1.39(16)	4.37(13)	1.71(14)	6.57(15)	2.07(13)	8.10(13)	2.28(15)
2.83(13)	1.57(14)	6.46(16)	2.11(14)	1.22(15)	2.22(16)	7.27(13)	4.03(14)	1.15(16)	3.77(13)	2.09(14)	5.44(15)	1.78(13)	9.88(13)	1.70(15)
3.04(13)	1.87(14)	7.05(16)	2.26(14)	1.44(15)	2.43(16)	7.82(13)	4.82(14)	1.26(16)	4.04(13)	2.49(14)	5.95(15)	1.91(13)	1.18(14)	1.87(15)
3.12(13)	2.19(14)	7.37(16)	2.32(14)	1.68(15)	2.55(16)	8.02(13)	5.62(14)	1.32(16)	4.15(13)	2.91(14)	6.26(15)	1.97(13)	1.38(14)	1.95(15)
3.07(13)	2.49(14)	7.09(16)	2.29(14)	1.90(15)	2.45(16)	7.89(13)	6.41(14)	1.26(16)	4.08(13)	3.31(14)	5.94(15)	1.92(13)	1.57(14)	1.87(15)
3.29(13)	2.82(14)	7.73(16)	2.45(14)	2.15(15)	2.67(16)	8.45(13)	7.25(14)	1.38(16)	4.38(13)	3.75(14)	6.57(15)	2.08(13)	1.78(14)	2.03(15)
3.28(13)	3.15(14)	7.79(16)	2.44(14)	2.34(15)	2.70(16)	8.45(13)	8.10(14)	1.39(16)	4.37(13)	4.19(14)	6.62(15)	2.07(13)	1.98(14)	2.15(15)

5C
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ev (Pu)[2]		E_n > 0.6 Mev (Np)[2]			E_n > 1.5 Mev (U)[2]			E_n > 2.9 Mev (S)			Gamma[3]	
	Acc. $nv_f t$	nv_f	$nv_f t$	Acc. $nv_f t$	nv_f	$nv_f t$	Acc. $nv_f t$	nv_f	$nv_f t$	Acc. $nv_f t$	ergs/gm(C)	R/sec
3)	8.73(13)	1.51(16)	4.52(13)	4.52(13)	7.18(15)	2.15(13)	2.15(13)	2.42(15)	7.23(12)	7.23(12)	1.9(7)	6.4(9)
3)	1.65(14)	1.30(16)	4.04(13)	8.56(13)	6.11(15)	1.90(13)	4.05(13)	1.92(15)	5.98(12)	1.32(13)	3.6(7)	5.6(9)
3)	2.46(14)	1.29(16)	4.17(13)	1.27(14)	6.10(15)	1.98(13)	6.03(13)	1.91(15)	6.19(12)	1.94(13)	5.4(7)	5.5(9)
3)	3.31(14)	1.39(16)	4.37(13)	1.71(14)	6.57(15)	2.07(13)	8.10(13)	2.28(15)	7.18(12)	2.66(13)	7.3(7)	5.9(9)
3)	4.03(14)	1.15(16)	3.77(13)	2.09(14)	5.44(15)	1.78(13)	9.88(13)	1.70(15)	5.57(12)	3.22(13)	8.9(7)	4.9(9)
3)	4.82(14)	1.26(16)	4.04(13)	2.49(14)	5.95(15)	1.91(13)	1.18(14)	1.87(15)	6.00(12)	3.82(13)	1.1(8)	5.4(9)
3)	5.62(14)	1.32(16)	4.15(13)	2.91(14)	6.26(15)	1.97(13)	1.38(14)	1.95(15)	6.15(12)	4.43(13)	1.2(8)	5.6(9)
3)	6.41(14)	1.26(16)	4.08(13)	3.31(14)	5.94(15)	1.92(13)	1.57(14)	1.87(15)	6.03(12)	5.03(13)	1.4(8)	5.4(9)
3)	7.25(14)	1.38(16)	4.38(13)	3.75(14)	6.57(15)	2.08(13)	1.78(14)	2.03(15)	6.45(12)	5.68(13)	1.6(8)	5 8(9)
3)	8.10(14)	1.39(16)	4.37(13)	4.19(14)	6.62(15)	2.07(13)	1.98(14)	2.15(15)	6.42(12)	6.32(13)	1.8(8)	5.9(9)

TABLE

AMPLIFIER DATA (+25°C) PRE-POST KEWB.

AMP. S/N	OPEN LOOP GAIN		CLOSED LOOP GAIN		Ic (ma)	
	PRE	POST	PRE	POST	PRE	POST
5A	200	198	8.0	8.0	4.2	4.2
5B	208	200	8.5	8.2	4.4	4.4
5C	212	190	8.5	8.0	4.2	4.15

NOTE: POST DATA MEASURED 13 DAYS AFTER LAST BURST.

TABLE

TRANSISTOR DATA (+25°C) PRE-POST KEWB.

IN AMPLIFIER S/N	DC BETA @5ma V_{CE} = IV		BV ceo @ 100μa/10 ma		BV cbo @ 100 μa		BV ebo @ 100 μa	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
5A	11	8.4	29/20	26/22	30	27	0.48	0.46
5A	12	10	29/19	25/21	29	26	0.50	0.49
5C	11	8.8	31/20	26/22	31	26	0.45	0.35

NOTE: POST DATA MEASURED 14 DAYS AFTER LAST BURST.